SECTION 21 - DOMESTIC WATER FACILITIES DESIGN CRITERIA

PART I - INTRODUCTION

21-1 DEFINITIONS

"Confined" The narrowing or tightening within boundaries in order to restrict the

accessible area for maintenance purposes.

"County" The County of Fresno.

"Developer" An individual or group proposing to subdivide or improve land within the

City and constructing improvements to be accepted by the City.

"Easement" A recorded document in which the land owner gives the City permanent

rights to construct and maintain water mains and/or facilities across

private property.

"Engineer" The City Engineer or other person designated by the City Council, acting

either directly or through authorized agents.

"Inspector" An employee or agent of the City engaged to observe and record field

compliance with design criteria, plans, and construction standards.

"Laboratory" The laboratory designated by the Engineer to test materials and work

involved in the contract and/or chemical and bacteria testing.

"Plans" The plans, profiles, cross-sections, working drawings, detail drawings,

and supplemental drawings, or exact reproductions thereof, approved by the Engineer, which show the locations, character, dimensions and

details of the work to be done.

"Reference Specifications"

Those bulletins standards, rules, methods of analysis or test, codes, and specifications of other agencies, engineering societies, or industrial associations referred to in the contract documents. These refer to the latest edition, including amendments in effect and published at the time of advertising the project or issuing the permit, unless specifically referred to by edition, volume, or date.

"Dept. of Public Utilities- Water Division"

The Division established by the City to administer the Water Systems.

"Health Agency"

The Department of Health Services. For those water systems supplying

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fewer than 200 service connections, the local health officer shall act for the Department of Health Services.

"Water Supplier"

"Person operating a public water system" or "supplier of water" means any person who owns or operates a public water system.

"Low Head Water Main"

Any water main which has a pressure of five psi or less at any time at any point in the main.

"Separation Dimensions"

The distance from outside of water main to outside of sewer line or manhole.

"Compression Joint"

A push-on joint that seals by means of the compression of a rubber ring or gasket between the pipe and a bell or coupling.

"Mechanical Joints"

A joint comprised of pipe spigot, a follower gland (ring), a mechanical joint gasket and the bell of an adjoining pipe, fitting or valve wherein the joint seal is accomplished by tightening a series of bolts and nuts that compress the gasket against the bell recess and the pipe spigot OD.

"Restrained Joints"

A non-standard or modified push-on or mechanical joint that is capable of preventing internal pressures or external forces from causing the joint to separate without the use of thrust blocks.

"Rated Working Water Pressure or Pressure Class"

A pipe classification system based upon internal working pressure of the fluid in the pipe, type of pipe material, and the thickness of the pipe wall.

"Fused Joint"

The jointing of sections of pipe using thermal or chemical bonding processes.

"Sleeve"

A protective tube of steel with a wall thickness of not less than one-fourth inch into which a pipe is inserted.

"Ground Water"

Subsurface water found in the saturated zone.

"House Lateral"

A sewer connecting the building drain and the main sewer line.

21-2 OTHER REQUIREMENTS

Ordinances, requirements, and applicable standards of governmental agencies having jurisdiction within the area served by the City's Water Division shall be observed in the design and construction of water mains and facilities.

Such requirements include, but are not limited to, current revisions of the following:

- 21-2.1 "Standard Specifications for Public Works Construction," latest edition, including all applicable supplements, prepared and promulgated by the California Chapter of the American Public Works Assn. and the Associated General Contractors of America
- 21-2.2 State Health Ordinances regulating the separation between water supply and sewerage facilities
- 21-2.3 The Uniform Plumbing Code as amended by the City of Fresno
- 21-2.4 Road encroachment regulations of the City of Fresno, County of Fresno, State of California, Fresno Irrigation District, and railroad permits where applicable.
- 21-2.5 American Water Works Association Standards.
- 21-2.6 Titles 17 and 24 of the State Health and Safety Code regulating cross connection control and back-flow prevention and City of Fresno Municipal Code Sections in Chapter 14, regulating cross connections for the City Water System.

PART II - GENERAL PROVISIONS

21-3 GENERAL REQUIREMENTS

21-3.1 Scope

The design and construction of water mains, facilities and other appurtenances for the City of Fresno shall comply with these specifications, or permit requirements of various governing bodies, except where specific modifications have been approved by the Engineer, in writing. A tentative plan must be submitted for comment prior to final design. All final plans submitted by the developer shall be signed by a registered civil engineer and all work shall be in accordance with good engineering practice.

21-3.2 Standard Criteria

The City of Fresno Standards set forth the procedure for designing and preparing plans and specifications for water mains, facilities and appurtenances to be built within the City's water service area. These standards shall include the attached specifications on design and installation of ductile iron pipe, and polyvinyl chloride (PVC) pressure pipe.

Whenever, water and sanitary sewer plans are to be designed and installed under one project, said work shall be shown on the same construction plans. In this case the developer's engineer shall supply the City the original tracings for the final record.

21-4 ENFORCEMENT

Provisions of these design and construction standards shall be enforced by the Engineer.

PART III - DESIGN CRITERIA

21-5 WATER MAIN PRESSURES, CAPACITIES, AND SIZES

21-5.1 Quantity of Domestic Flow

Water needs shall be determined from maximum potential population and land use of the area to be served. For design purposes, the design domestic flow shall equal the peak hour demand. In order to determine the design domestic flow, the following criteria shall be used, unless otherwise approved by the Engineer.

(a) 5 G.P.M. per service plus fire flow. For commercial, manufacturing and industrial, the Engineer shall be contacted for approval of values to be used.

21-5.2 Quantity of Fire Flow.

Fire flow shall be determined, using the Insurance Services Office <u>Guide for Determination of Required Fire Flow</u>, latest edition or as designated by the City of Fresno Fire Department. Criteria for fire system design requires that the system pressure at the point of delivery should be at least 20 pounds per square inch under peak hour flow conditions, plus fire flow.

Fire Flow at residential fire hydrants shall be a minimum of 1,500 GPM with a water system residual pressure of 20 pounds per square inch.

Design of water main sizing shall include fire flow requirements and domestic and/or industrial water demand.

21-5.3 Pressure

Water mains shall be designed so that service pressures range between 45 and 60 psi, except under fire flow conditions where a residual pressure of 20 psi is allowable.

21-5.4 Velocity

Water mains shall be designed to provide a mean velocity not more than five (5) feet per second under Maximum Daily Demand flow.

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21-5.5 Head Loss

Water mains shall be designed to provide a mean head loss of not more than five (5) feet per thousand feet of pipe under Maximum Daily Demand flow.

21-5.6 Hazen-Williams "C"

Pipe analysis shall be performed by assuming a value of 110 for Hazen-Williams coefficient "C".

21-5.7 Minimum Water Main Size

Water Mains shall have an inside diameter of six (6) inches or more, where fire flow is to be transported. Four (4) inch mains may be permitted by the Engineer for cul-de-sacs, 150 feet and shorter when the main serves less than five services and when no fire hydrant is connected to the main.

21-6 LOCATION OF AIR RELEASE VALVE ASSEMBLIES

Air release valve assemblies shall be located at all points where air pockets may form and at locations shown and/or established by the Engineer.

21-7 LOCATION OF BLOW-OFF ASSEMBLIES

Blow-off assemblies shall be located at low points and dead ends, where sediment may collect. Fire hydrants may be substituted for blow-off assemblies. Design class shall be compatible with the pipeline working pressure.

21-8 FIRE HYDRANT ASSEMBLIES

Location of, and fire flow rate at, fire hydrant assemblies shall be approved by the City of Fresno Fire Dept. prior to approval of plans by the Engineer and Water Systems Manager.

21-9 WATER MAIN LOCATIONS

21-9.1 Water Main Location in Roads or Streets

The centerline of water mains shall be located in public streets in accordance with Drawing P-46 of Standard Specifications. A Minimum of ten (10) feet of clearance must be maintained between parallel sewer and water lines. Water line locations shall be dimensioned from property line and centerline or section line of the street.

21-9.2 Curved Water Main Requirements.

In curved streets the water main shall not cross the center line, but shall follow the street curvature using joint deflections or fittings or as shown on the drawings. Bending of PVC pipe barrels to accomplish horizontal or vertical curves is not permitted.

21-9.3 Joint Deflections for Curved Water Main

Deflection in joints of pipe shall be as limited by manufacturers recommendation.

21-9.4 Elbows

Elbows shall be placed at locations where coupling deflection would exceed the allowable, as limited by manufacturers recommendation.

21-9.5 Water-Sewer Separation

The provisions of State Health Codes shall be met in locating water mains.

21-10 CRITERIA FOR THE SEPARATION OF WATER MAINS AND SANITARY SEWERS

21-10.1 Basic Separation Standards

The "California Waterworks Standards" sets forth the minimum separation requirements for water mains and sewer lines. These Standards, contained in section 64630, Title 22, California Administrative Code, specify:

- (a) (1) Parallel Construction: The horizontal distance between pressure water mains and sewer lines shall be at least 10 feet. See Figure 1.
- (b) (2) Perpendicular Construction (Crossing): Pressure water mains shall be at least one foot above sanitary sewer lines where these lines must cross. See Figure 2.
- (c) Separation distances specified in (a) shall be measured from the nearest edges of the facilities.
- (d) Common Trench: Water mains and sewer lines must not be installed in the same trench.

When water mains and sanitary sewers are not adequately separated, the potential for contamination of the water supply increases. Therefore, when adequate physical separation cannot be attained an increase in the factor of safety should be provided by increasing the structural integrity of both the pipe materials and joints.

21-10.2 Exceptions to Basic Separation Standards

Local conditions, such as available space, limited slope, existing structures, etc.; may create a situation where there is <u>no alternative</u> but to install water mains or sewer lines at a distance less than that required by the Basic Separation Standards. In such cases, alternative construction criteria as specified in Section 21-11 should be followed, subject to the special provision in Section 21-10.3.

Water mains and sewers of 24 inches diameter or greater may create special hazards because of the large volumes of flow. Therefore, installations of water mains and sewer lines 24 inches diameter or larger should be reviewed and approved by the health agency prior to construction.

21-10.3 Special Provisions

The Basic Separation Standards are applicable under normal conditions for sewage collection lines and water distribution mains. More stringent requirements may be necessary if conditions, such as, high groundwater exist.

Sewer lines shall not be installed within 25 feet horizontally of a low head (5 psi or less pressure) water main.

New water mains and sewers shall be pressure tested where the conduits are located ten feet apart or less.

In the installation of water mains or sewer lines, measures should be taken to prevent or minimize disturbances of the existing line. Disturbance of the supporting base of this line could eventually result in failure of this existing pipeline.

Special consideration shall be given to the selection of pipe materials if corrosive conditions are likely to exist. These conditions may be due to soil type and/or the nature of the fluid conveyed in the conduit, such as a septic sewage which produces corrosive hydrogen sulfide.

(a) Sewer Force Mains

Sewer force mains shall not be installed within ten feet (horizontally) of a water main.

When a sewer force main must cross a water line, the crossing should be as close as practical to the perpendicular. The sewer force main should be at least one foot below the water line.

When a new sewer force main crosses under an existing water main, all portions of the sewer force main within ten feet (horizontally) of the water main shall be enclosed in a continuous sleeve.

When a new water main crosses over an existing sewer force main, the water main shall be constructed of pipe materials with a minimum rated working pressure of 200 psi or equivalent pressure rating.

21-11 ALTERNATE CRITERIA FOR CONSTRUCTION

The construction criteria for sewer lines or water mains where the Basic Separation Standards cannot be attained are shown in Figure 1 and 2. There are two situations encountered:

- Case 1 New sewer line new or existing water main.
- Case 2 New water main existing sewer line

For Case 1, the alternate construction criteria apply to the sewer line.

For Case 2, the alternate construction criteria may apply to either or both the water main and sewer line.

The construction criteria should apply to the house laterals that cross <u>above</u> a pressure water main but not to those House laterals that cross below a pressure water main.

Case 1: New Sewer Being Installed (Figures 1 and 2)

Zone Special Construction Required for Sewer

- A. Sewer lines parallel to water mains shall not be permitted in this zone without approval from the responsible health agency and water supplier.
- B. A sewer line placed parallel to a water line shall be constructed of:
 - 1. Extra strength vitrified clay pipe with compression joints.
 - 2. Plastic sewer pipe with rubber ring joints (per ASTM D3034) or equivalent.
 - 3. Ductile iron pipe with compression joints.
 - 4. Reinforced concrete pressure pipe with compression joints (per AWWA C302-74).
- C. A sewer line crossing a water main shall be constructed of:
 - 1. A continuous section of ductile iron pipe with hot dip bituminous coating and mechanical joints.
 - 2. A continuous section of Class 200 (DR 14 per AWWA C900) plastic pipe or equivalent, centered on the pipe being crossed.
 - 3. A continuous section of reinforced concrete pressure pipe (per AWWA C302-74) centered on the pipe being crossed.
 - 4. Any sewer pipe within a continuous sleeve.
- D. A sewer line crossing a water main shall be constructed of:
 - 1. Ductile iron pipe with hot dip bituminous coating and mechanical joints.

- 2. A continuous section of Class 200 (DR 14 per AWW A C900) plastic pipe or equivalent, centered on te pipe being crossed.
- 3. A continuous section of reinforced concrete pressure pipe (per AWWA C302-74) centered on the pipe being crossed.
- 4. Any sewer pipe within a continuous sleeve.
- 5. Any sewer pipe separated by a ten-foot by ten-foot, four-inch-thick reinforced concrete slab.

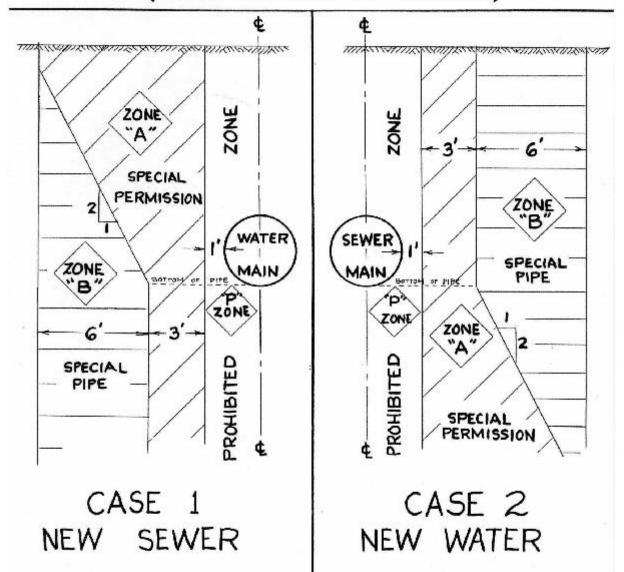
Case 2: New Water Mains Being Installed (Figures 1 and 2)

Zone

- A. No water mains parallel to sewers shall be constructed without approval from the health agency.
- B. If the sewer paralleling the water main does not meet the Case 1, Zone B, requirements, the water main shall be constructed of:
 - 1. Ductile iron pipe with hot dip bituminous coating.
 - 2. Class 200 pressure rated plastic water pipe (DR 14 perAWWAC900) or equivalent.
- C. If the sewer crossing the water main does not meet the Case 1, Zone C, requirements, the water main shall have no joints in Zone C and be constructed of:
 - 1. Ductile iron pipe with hot dip bituminous coating.
 - Class 200 pressure rated plastic water pipe (DR 14 per AWWA C900) or equivalent.
- D. If the sewer crossing the water main does not meet the requirements for Case 1, Zone D, the water main shall have no joints within four feet from either side of the sewer and shall be constructed of:
 - 1. Ductile iron pipe with hot dip bituminous coating.
 - Class 200 pressure rated plastic water pipe (DR 14 per AWWA C900) or equivalent.

PARALLEL CONSTRUCTION

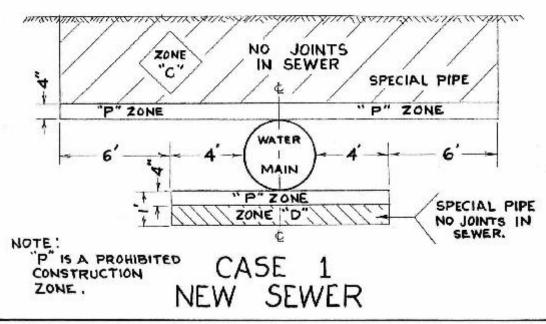
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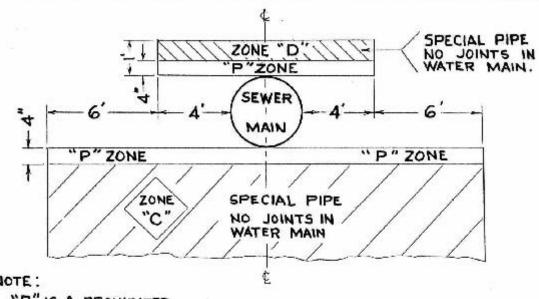


NOTES:

- 1. ZONES ARE IDENTICAL ON EITHER SIDE OF CENTER LINES.
- 2."P"ZONE IS A PROHIBITED CONST. ZONE PER SECTION 64630, TITLE 22, CALIF. ADMINISTRATIVE CODE.

WATER & SEWER MAIN CROSSINGS





NOTE:

"P" IS A PROHIBITED CONSTRUCTION ZONE .

CASE 2 NEW WATER

21-12 PROCEDURE FOR WATER AND SEWER SYSTEM INSTALLATIONS IN SUBDIVISIONS

- a. Installation of all sewer mains, laterals and manholes and backfill.
- b. Installation of all water mains, services and hydrants and backfill.
- c. Compact all sewer trenches.
 - d1. Make preliminary pressure test. (Optional)
 - d2. Locate and repair leaks, if any.
 - d3. Recompact if necessary.
- e. Compact all water trenches.
 - e1. Make preliminary pressure test. (Optional)
 - e2. Locate and repair leaks, if any.
 - e3. Recompact if necessary.
- f. Items (d) and (e) may be done simultaneously if conditions permit.
- g. All trenches should be identified. Contractor shall also locate and mark sewer and water on curb face when constructed.
- h. Compaction tests on sewer and water taken by City.
- i. Final air test for sewer and pressure test for water, providing all leaks are repaired and all compaction tests have been approved.
- j. Any failure of final tests would require contractor to reinitiate sequence of work starting with Item (h).
- k. The Water Division will construct the wet tie to connect to the City's system. This will allow the Contractor to sterilize and flush the newly constructed system. There is often an associated charge for the construction of these wet ties.
- I. Flushing water mains shall not be allowed in street area if it conflicts with sewer and water installations. Often done after compaction tests have passed. Water seeps into trenches and holds up developers paving while street dries out.
- m. If storm sewers are to be installed, they shall be constructed first, unless otherwise directed.

21-13 EASEMENTS

Non-metallic pipes may be allowed in easements which are neither confined or interior easements.

21-13.1 Easements

The minimum width of a water facility easement shall be approved by the City Engineer.

21-13.2 Water Main Location in Easement

The water main shall be located 5 feet north or west of the center line of the easement except where otherwise approved by the Engineer.

21-13.3 Where Easements Follow Common Lot Lines

The full easement width shall be on one lot, in such a manner that access to lines will not be obstructed by walls, trees, or permanent improvements. Where this requirement cannot be met without interfering with existing buildings, easements may straddle lot lines, but the water line shall not be located on the lot lines.

21-13.4 Deeds for Easements

Deeds for easements shall provide for restrictions of permanent construction within the easement to provide ingress and egress for maintenance. A recent title report will be required prior to acceptance of the easement.

21-13.5 Dedications

Dedications shall be in accordance with City of Fresno standard practice.

- (A) For subdivision tracts the owners of land included within the subdivision shall provide a bill of sale on a form provided by the City of Fresno. This bill of sale shall be a part of the acceptance of the subdivision.
- (B) For other than subdivision tracts, the following shall be conveyed to the City:
 - (1) A deed of easement satisfactory to the City for the operation maintenance of the water facilities shall be prepared by a registered engineer or land surveyor, on City of Fresno easement forms properly executed by the owners;
 - (2) A bill of sale to the City of Fresno for the water mains and appurtenances.

21-14 DEPTH OF WATER MAINS

21-14.1 Basic Requirements

Water mains shall be installed at a depth which shall be in accordance with the applicable ordinances, regulating the separation between water supply and sewerage facilities.

21-14.2 Standard Depths

Minimum depth shall be 42 inches to top of pipe measured from street or surface above the pipe. Where the natural ground above the pipe line trench has been over-excavated and/or the pipe line is to be placed in the new embankment, embankment material shall be placed and compacted to an elevation of not less than 3 feet above the top of pipe prior to the trench excavation. Where 42" from top of curb cannot be maintained, pipe shall be installed with selected or imported bedding as approved by the Engineer or metallic pipe material shall be used.

21-14.3 Exceptions

Designs not in accordance with Figure 2 shall be submitted to the Engineer for approval together with evidence that it complies with Figure 1.

21-15 STRUCTURAL REQUIREMENTS

21-15.1 Buried Facilities

All structures and pipe placed underground shall be of sufficient strength to support with an adequate factor of safety the following applicable loads: the backfill, road surfacing, H-20 truck loading with impact, high loading to be specified by the Engineer or as required by permits for crossing state highways, railroad tracks, canals, and streams. Calculations showing factor of safety may be required by the Engineer.

21-15.2 Other Pipes and Structures

Water lines designed to cross under other pipes or structures shall be protected from damage and shall be constructed in order not to endanger the other pipe or structure. Minimum clearance between outside of pipes or between pipes and other structures is 12 inches unless otherwise approved by the Engineer.

21-15.3 Flexible Joints

Flexible joints which will allow for differential settlements or other movement of water pipe, facilities, adjacent pipe and adjacent structures shall be provided where water lines enter encasements or other structures. Flexible joints shall be within three feet of such structures. Any deviations from these requirements shall require approval from the Engineer.

21-15.4 Thrust Blocks

The use of concrete thrust blocks may be required but will only be allowed when specifically approved in writing by the Engineer.

21-15.5 Mechanical Restrained Joints

Restrained joint fittings shall be provided at all tees, crosses, reducers, bends, caps, plugs and valves such that the pipe is fully restrained in any one given direction.

These shall meet <u>Uni-B-13</u> and ASTM F 1674-96 for PVC and be UL/FM approved through 12" for both ductile iron and PVC. The restraint mechanism shall consist of individually activated gripping surfaces to maximize restraint capability. Twist-off nuts, sized the same as the tee-head bolts, shall be used to insure proper activating of restraining devices. The gland shall be manufactured of ductile iron conforming to ASTM A536-80. The retainer-gland shall have a pressure rating equal to that of the pipe on which it is used through 14" with a minimum safety factor of 2:1. See Standard Drawings W-31, W-32, W-33, W-34, W-35, W-36, W-37. Gland shall be Megalug by EBAA Iron, Inc., Uni-Flange by Ford Meter Box Co. Inc., or approved equal.

Push-on Restraint When it is necessary to restrain push-on joints adjacent to

restrained fittings, a harness restraint device shall be used. All harnesses shall have a pressure rating equal to that of the pipe on which it is used through 14". Harness assemblies including tie bolts shall be manufactured of ductile iron conforming to ASTM A536-80. Harness shall be manufactured by EBAA Iron, Inc., Ford Meter Box Co. Inc., or approved equal.

21-16 DESIGN CRITERIA FOR WATER METERS

The City shall determine the appropriate meter sizes and types, based on the building plumbing plans and the landscape sprinkler plans furnished by the developer. Unless otherwise required by the Engineer, the aforementioned determination is not required for single-family residential units, where a minimum 1" service for each unit is required.

PART V - MATERIALS

21-17 REQUIREMENTS

Materials shall be chosen for their strength, durability and ease of maintenance, with due consideration for dead and live loads, beam strength and resistance to corrosion. Pipe joints shall be selected to provide sufficient flexibility to adjust to the residual conditions during and after construction.

21-18 PIPE MATERIALS

The following are acceptable materials for water line construction:

21-19 DUCTILE IRON PIPE AND DUCTILE IRON FITTINGS

Ductile iron pipe and associated fittings shall conform to the applicable sections of the Standard Specifications.

(a) Fabrication

Ductile iron pipe shall be pressure class 350 ductile iron for sizes up to and including 12 inch and pressure class 250 ductile iron from 14 inch to 20 inch; complete with all accessories and conforming to ANSI/AWWA C151/A21.51, unless otherwise indicated on the construction plans. Ductile iron pipe shall be eighteen (18) foot laying lengths.

(b) Joints

Joining of ductile iron pipe shall be with elastomeric-gasket bell ends or couplings. The joints and rubber gaskets shall be in conformance with ANSI/AWWA C111/A21.11.

(c) Inspection and Testing

City at its discretion may inspect the plant facilities, materials, manufacture and testing of the pipe to be furnished by Contractor.

Testing of the pipe to insure compliance with these specifications shall be made in accordance with applicable AWWA Standards latest edition. All cost incurred by City for witnessing the manufacture of the pipe and in obtaining test results shall be borne by Contractor furnishing the pipe.

(d) Affidavit of Compliance

City may elect to waive any of the above testing and inspection requirements in which event the Engineer may require the manufacturer to submit affidavits stating that all pipe has been manufactured and tested in accordance with this specification.

(e) Fittings

All fittings for use with ductile iron pipe shall be ductile iron manufactured in accordance with ANSI/AWWA C110/A21.10 or ANSI/AWWA C153/A21.53. All mechanical joint or push-on joint fittings shall be rated for 350 psi working pressure in sizes 4" through 24". Flange fittings shall be rated ro 250 psi working pressure. Flange drilling pattern shall be in accordance with ANSI/AWWA C110/A21.10, or commonly referred to as a 125# drilling pattern.

In accordance with Section 4.3 of ANSI/AWWA C153/A21.53, fittings may be provided with a cement-mortar lining and asphalt coating or fusion bonded epoxy inside and outside. Fusion bonded epoxy shall be in accordance with ANSI/AWWA C116/A21.16 and shall be applied to interior and exterior surfaces.

All tees and crosses shall have all flanged ends with the exception of fire hydrant, blowoff, and pumping connections, which shall have flange by mechanical joint or pushon joint ends; reducers shall have flange by mechanical joint ends; elbows maybe either mechanical joint or flanged ends.

(f) Appurtenances

All appurtenances used in conjunction with the ductile iron pipe shall meet the City Standard Specifications.

21-19.1 Confined Easements

All confined easement construction shall be ductile iron.

21-19.2 Polyvinyl Chloride (PVC) Pressure Pipe

Polyvinyl chloride (PVC) pressure pipe shall conform to the applicable sections of the Standard Specifications.

(a) Fabrication

Polyvinyl chloride pressure pipe shall be Class 150 DR 18 for 12" and smaller and Class 235 DR 18 for 14" and larger and shall conform to AWWA C-900 latest edition for 12" and smaller and AWWA C905 latest edition for 14" and larger, unless otherwise indicated on the construction plans.

All Polyvinyl Chloride (PVC) pipe shall be twenty (20) foot laying lengths. PVC Pipe shall have cast iron pipe outside diameters (C.I.O.D.)

(b) Joints

Joining of PVC pipe shall be with elastomeric-gasket bell ends or couplings. The bell ends shall be an integral thickened bell end (IB) or and integral sleeve-reinforced bell end. The bell end joints shall have a minimum wall thickness of the bell or sleeve-reinforced bell equal, at all points, to the DR Requirements for the pipe. The minimum wall thickness in the ring groove and bell-entry sections shall equal or exceed the minimum wall thickness of the pipe barrel.

If bell ends are not part of the pipe, one PVC coupling, manufactured of the same material and by the same manufacturer as the pipe, shall be furnished with each length of pipe together with two (2) rubber rings. The coupling shall be designed to insure a water-tight joint with the pipe. The coupling body and socket shall have a wall thickness equal to the pipe barrel thickness with which the coupling is to be used.

All rubber rings shall be furnished by the pipe manufacturer. These rubber rings (Elastomeric Gaskets) shall be manufactured to conform with the requirements of ASTM F-477.

(c) Hydrostatic Proof-test

Each length of pipe shall be proof-tested at four (4) times its rated pressure class for a minimum dwell of five (5) seconds.

(d) Inspection and Testing

City at its discretion may inspect the plant facilities, materials, manufacture and testing of the pipe to be furnished by Contractor.

Testing of the pipe to insure compliance with these specifications shall be made in accordance with applicable AWWA Standards latest edition. All cost incurred by City for witnessing the manufacture of the pipe and in obtaining test results shall be borne by Contractor furnishing the pipe.

(e) Affidavit of Compliance.

City may elect to waive any of the above testing and inspection requirements in which event the Engineer may require the manufacturer to submit affidavits stating that all pipe has been manufactured and tested in accordance with this specification.

(f) Fittings

All fittings for use with Polyvinyl chloride pipe shall be ductile iron manufactured in accordance with ANSI/AWWA C110/A21.10 or ANSI/AWWA C153/A21.53. All mechanical joint or push-on joint fittings shall be rated for 350 psi working pressure in sizes 4" through 24". Flange fittings shall be rated for 250 psi working pressure. Flange drilling pattern shall be in accordance with ANSI/AWWA C110/A21.10, or commonly referred to as a 125# drilling pattern.

In accordance with Section 4.3 of ANSI/AWWA C153/A21.53, fittings may be provided with a cement-mortar lining and asphalt coating or fusion bonded epoxy inside and outside. Fusion bonded epoxy shall be in accordance with ANSI/AWWA C116/A21.16 and shall be applied to interior and exterior surfaces.

All tees and crosses shall have all flanged ends with the exception of fire hydrant,

blowoff, and pumping connections, which shall have flange by mechanical joint or pushon joint ends; reducers shall have flange by mechanical joint ends; elbows maybe either mechanical joint or flanged ends. A/C to C.I.O.D. PVC adapter rings may not be used.

(g) Appurtenances

All appurtenances used in conjunction with PVC shall meet the City Standard Specifications.

21-20 VALVES

21-20.1 Butterfly Valves

(a) General

These specifications designate the requirements for the manufacture and installation of butterfly valves. The Contractor shall furnish all labor, materials, tools and equipment necessary to install, complete and ready for operation, the valves as shown on the plans and herein specified.

(b) Materials and Workmanship

Butterfly valves shall be of the rubber-seated tight-closing type. They shall meet or exceed AWWA Standard C504 latest revision. All valves must use full AWWA C504 Class 150B valve shaft diameter, and full Class 150B underground-service-operator torque rating throughout entire travel. All valves shall be NSF approved. Valve body shall be high-strength cast iron ASTM A126 Class B with 18-8 Type 304 stainless steel body seat. Valve vane shall be high-strength cast iron ASTM A48 Class 40, having rubber seat mechanically secured with an integral 18-8 stainless steel clamp ring and 18-8 stainless steel self-locked screws.

Rubber seat shall be full-circle 360 degree seat not penetrated by the valve shaft. Valve shaft shall be one piece, extending full size through the entire valve. Valve shaft shall be 304 stainless steel. Packing shall be O-ring cartridge designed for permanent duty underground. All exposed cap screws and fasteners on the valve body and flanges shall be Ni-Cad steel or approved equal.

(c) Valve Operators

Valve operators shall be of the manual type. The operator shall be totally enclosed, self-locking worm gear or screw type, with adjustable stops to limit disc travel. The number of complete turns of the operator required to rotate this disc 90 degrees shall be approximately the same as an equivalent sized gate valve. All valve operators shall be fully gasketed, weather-proof and factory packed with grease. Operators shall be of the size required for opening and closing the valve against 150 PSI water pressure, and shall have a torque rating of not less than shown in AWWA C-504, 1, Class 150-B. Operators for valves located above ground shall have disc-position indicators and a hand-wheel.

Should the difference between the operating nut and the valve cover exceed 50 inches, an extension mast shall be installed in order that the operating nut not exceed 50 inches from the valve cover or grounds surface. Buried operators shall be worm gear or screw

type and shall be threaded to accommodate a two inch operating nut, and shall include the operating nut, and shall include 3/4" hex head plated bolt for operating nut hold-down. All exposed fastenings shall be specifically designed and suitable for permanent buried service. Input shaft and thread for the operating nut shall be at a right angle to the operating shaft. The input shaft shall extend vertically from the side when the valve is in the horizontal position.

Epoxy shall be applied to all surfaces of valve body and vane to an average minimum thickness of 5 mils, conforming to AWWA C 550 Standards. A primer shall be applied before the coating per the epoxy manufacturers recommendations. The coating shall be applied to the entire valve body and vane before final assembly.

(d) Valve Ends

Valve ends shall be for mechanical joint pipe and shall conform to ANSI CIII (AWWA A21.11-1972, Class 125) and drilled to ANSI B16.1 for cast iron flanges and flanged fittings, Class 125. Flanges shall be 125# ANSI.

The butterfly valves shall be right closing Class 150-B designed for tight shut off with a maximum differential pressure across the disc of 200 psi. Valve shafts shall consist of a one-piece unit extending completely through the valve disc.

(e) Valve Boxes, Nuts and Bolts, Gaskets and Marker Posts shall conform to the provisions specified herein for gate valves.

21-20.2 Gate Valves

(a) General.

These specifications designate the requirements for the manufacture and installation of gate valves. The Contractor shall furnish all labor, materials, tools and equipment necessary to install, complete and ready for operation, the valves as shown on the plans and herein specified.

(b) Materials and Workmanship.

Gate valves shall be non-rising stem resilient seated type. Valves shall conform to the latest version of AWWA C-509 and C-550. Valve bodies shall be ductile iron and wedges shall be fully rubber encapsulated.

The stem shall have two O-rings above the collar and one O-ring below the collar. Stem seals must be replaceable with the valve under pressure. The stem material shall be stainless steel [ANSI-420], low zinc bronze or manganese bronze. The waterway shall be full size. No cavities or depressions are permitted in the seat area. Valve body and bonnet shall be electrostatically applied, fusion bonded, epoxy coated both inside and out by the valve manufacturer. The coating shall meet the requirements of AWWA C-550 and NSF 61 approved. All valve body and bonnets bolts and nuts shall be type 304 stainless steel.

All valves must be tested by hydrostatic pressure equal to the requirements in the AWWA C-509 specifications prior to shipment.

Tapping gate valve assemblies shall be used only in conjunction with tapping sleeves and shall be furnished and installed by the City Water Division.

Nuts and bolts used for bolting flanged-end gate valves to pipeline flanges above ground, shall be hexagonal head machine bolts and hexagonal nuts conforming to ASTM A307, Grade B. All buried flanged-end gate valves shall be bolted to the pipe line flanges with Ni-Cad nuts and bolts or approved equal.

(c) Gaskets

Gaskets for flanged-end gate valves shall be ring face 1/8".

(d) Valve Ends

Valves may be provided with mechanical joint ends, push-on joint ends, flanged ends, mechanical joint by flange ends or push-on joint by flange ends.

21-21 APPURTENANCES

21-21.1 Blow-off Assemblies for Water Mains

(a) General.

Blow-off assemblies shall be furnished and installed by the Contractor at the locations shown on the plans. The Contractor shall furnish all labor, materials, tools and equipment necessary to furnish and install, complete and ready for operation, the assemblies as shown on the plans and herein specified. See Standard Drawings W-9 and W-10.

- (b) Materials, Fabrication and Installation.
 - (1) <u>Materials.</u> Shall be ductile iron and sized as designated on the Standard Drawings W-9 and W-10 or on the plans.
 - (2) Valves. Gate valves or butterfly valves for blow-off assemblies shall be as specified herein.
 - (3) <u>Pipe and Fittings.</u> Shall be 4 inch or 6 inch ductile iron and shall conform with the standard for ductile iron pipe water main and fittings. Joints on the water main side of the gate valves shall be flanged. Properly restrained MJ fittings are allowed downstream of the gate valve.
 - (4) Pipe Sleeves and Lids shall be used per City Standard Drawing W-7.
 - (5) Meter Boxes and Covers shall be per City Standard Drawing W-9 and W-10 or Engineer approved equivalent and marked "Water". Covers shall be seated flush with the surface of the natural ground or paved surface, such that they may not be damaged by, nor present an obstruction or rough surface to traffic.

21-21.2 Air Release Valve Assemblies.

(a) General

Air release valve assemblies shall be furnished and installed by the Contractor at all points where air pockets may form and at the locations shown and/or established in the field by the Engineer. The Contractor shall furnish all labor, materials, tools and equipment necessary to install, complete and ready for operation, the valve assemblies shown on the plans and herein specified. See Standard Drawing W-13.

- (b) Materials, Fabrication and Installation
 - (1) Materials shall be in accordance with Standard Drawings. The valve shall be a 'Val-matic model 3/4-25VC' or approved equal.

21-21.3 Water Service Assemblies (2 inches and smaller).

(a) General

Water service assemblies shall be furnished and installed by the Contractor at the locations shown on plans or established in the field by the Developer. The Contractor shall furnish all labor, materials, tools and equipment necessary to install, complete and ready for operation, the assemblies as show on the plans and herein specified. The Contractor shall perform the installation of the lot services in accordance with the Standard Drawings Nos. W-1 & W-2. The developer shall provide the City with a plan showing the "As Built" location of all services.

- (b) Materials, Fabrication, and Installation
 - (1) Materials. Shall be those designated on the standard drawings or plans. See Drawing Nos. W-1.
 - (2) Pipe and Fittings. Service pipe shall be Type K soft copper tubing, or Polyethylene CTS 200 psi SDR-9 PE 3408. Solder fittings shall be soldered with 95% tin / 5% lead or silver solder (pure).

Service Size	Corp. Stop	Service Pipe	Angle Meter Stop
1"	1"	1"	1"
1-1/2"	1 ½"	1½ "	
2"	2"	2"	

(3) Saddles. Service saddles shall be used for all 1", 1-1/2", and 2" taps made on ductile iron and PVC pipe. A circumferential type stainless steel band or bands shaped to fit the actual O.D. of the pipe shall be used. Double strap bands shall provide a minimum bearing width of 1-1/2 inches per band along the axis of the pipe. Single strap bands shall provide a minimum bearing width of 3 inches per band along the axis of the pipe. Saddles shall not have lugs that will cut into the pipe when the saddle is tightened. Saddles are to be Jones, Ford, Mueller or approved equal.

Multiple O.D. range saddles shall not be used.

(4) Service Taps. In no case shall a service tap be made in a main closer than 18 inches to a bell coupling joint, or fitting. Service taps shall not be less than two

feet apart. Service taps shall be located opposite the service locations so that the service laterals will be perpendicular to the street centerline. Service tap locations varying more than two feet from the perpendicular must be approved by the Engineer prior to installation. Service taps shall be in accordance with Drawings W-1 & W-2. Where dissimilar metals are joined, a dielectric connection, approved by the Engineer shall be provided. Hole size drilled in the pipe shall be the same size as the corporation stop. The cutting tool shall be a shell type (hole) cutter which will retain the coupon.

Tapping sleeves and corp stop valves shall be used for service connections of 2 inches and smaller. For ductile iron water mains, double strap ductile iron service saddles must be used.

(5) Service Boxes

Service casing and covers and meter boxes and covers shall be furnished and installed by the Contractor as shown of Standard Drawings. Nos. W-1 & W-2. All service casings shall be complete and in place at the time of acceptance of the subdivision. All services shall be marked by an "X" or "W" clearly visible on the curb face. Minimum size 1 $\frac{1}{2}$ " X 1 $\frac{1}{2}$ " maximum 3" X 3".

(6) Curb Stops in Driveways

The developer has the following alternatives for services located in driveways:

- (a) Curb stops remaining in driveways shall be placed inside a meter box with an H20 rated traffic lid.
- (b) Relocate outside of driveway a minimum distance of one foot.

Services must be relocated by City Forces after the sterilization phase of the new water system has been passed. The cost for relocation will be the actual cost of labor, equipment and materials.

(7) Meters

Meters shall be furnished and installed by the City. The developer shall pay any fees established by the City Council.

21-21.3 Valve Service Casing and Lid

Valve Service Casing and Lid Shall conform with Standard Drawings. Valve covers shall be cast-iron Kearney Manufacturing Roll-in Frame No. KP 2050 and Roll-in Cover No. KP 3050 or approved equal and shall be marked as shown on the Standard Drawings. Covers shall be seated flush with the surface of the natural ground or paved surface such that they may not be damaged by, or present an obstruction or rough surface to traffic. Covers shall have a 9 inch wide and 6 inch thick stabilizing concrete ring constructed when the valve is outside the pavement area.

SECTION 22 - WATER FACILITIES

22-1 SCOPE

These Standards are intended to describe the execution and workmanship to be used in construction of a water system operated in the City of Fresno. It is presumed that the developer or his engineer has prepared such general and special specifications as are necessary to define the nature and location of the work, contractual arrangements, payment for work, and any other matters concerning the owner or his Contractor. All street work permits shall be obtained and fees shall be paid by the developer or Contractor.

22-2 GENERAL

22-2.1 Quality Control of Materials

The quality control of materials shall conform to the applicable sections of the Standard Specifications as published by the City of Fresno.

22-2.2 Quality of Workmanship

All work will be done by persons experienced in the specific work, under competent supervision and in a first class manner to the Engineer's complete satisfaction. Every precaution shall be taken to prevent foreign material from entering the pipe while it is being placed in the trench. If the pipe-laying crew cannot put the pipe into the trench and in place without getting earth into it, the Engineer may require that before lowering the pipe into the trench a heavy tightly woven burlap bag of suitable size shall be placed over each end and left there until the connection is to be made to the adjacent pipe. During laying operations, no debris, tools, clothing or other materials shall be placed in the pipe. After placing a length of pipe in the trench and completing the jointing operation, in a method approved by the pipe manufacturer, the pipe shall be secured in place with approved backfill material placed under it. At times when pipe laying is not in progress, the open ends of the pipe shall be closed by a watertight plug or other means approved by the Engineer. This provision shall apply during any work stoppage.

22-2.3 Connections to Existing Facilities

Connections shall be performed by Water Division personnel only. Three (3) days notice shall be given before any connection is to be made.

22-2.4 Defective Work

Any defective materials or workmanship which shall become evident within one year after the City assumes responsibility for the completed work shall be replaced or repaired without cost to the City. Refusal of the Contractor to correct defective work which is his responsibility will be considered just cause for excluding him from performing future work to be connected to the City's system. Such exclusion does not impair the City's right to bring legal action to correct the deficiencies.

22-2.5 Construction Staking and "Record-Drawings"

Construction stakes will be set parallel to the water main alignment at an offset distance and direction agreed upon with the Contractor but in no case shall construction stakes be offset more than 10 feet. Stakes will be set at no greater interval than 100 feet on straight alignments. For horizontally or vertically curved water mains, the stake intervals shall be 25 feet. For all street water mains, regardless of alignment or slope, the developer's engineers shall determine "Record-Drawings" elevations at the top of pipe centerline at each change in pipe grade and shall provide a written record of such elevations to the inspector. The developers' engineer shall also provide "Record-Drawings" of all main line valve locations and all service stop locations.

22-3 POLYVINYL CHLORIDE (PVC) PRESSURE PIPE AND FITTINGS INSTALLATION

22-3.1 Scope of Work

The Contractor performing the work under this specification shall furnish all labor tools and equipment, which are necessary to install, complete, and ready for operation, the PVC pressure pipe water mains as herein specified and/or as indicated on the contract drawings.

22-3.2 Installation

Installation shall conform to Chapter 7, Installation, of AWWA Standard C 605 and AWWA Manual M23. Bending of PVC pipe barrels to accomplish horizontal or vertical curves is not permitted.

22-3.3 Tracer Wire

Tracer wire used with PVC where called for on the plans shall be copper wire, Type TW, Size AWG #10 and shall be placed under the PVC water main. Tracer tape is not allowed. All wire to wire connections shall be soldered to provide continuity and taped to prevent entry of moisture. Where tracer wire is called for, it shall be securely attached to each fire hydrant and each main line valve casing.

22-4 DUCTILE IRON PRESSURE PIPE AND FITTINGS INSTALLATION

22-4.1 Scope of work

The Contractor performing the work under this specification shall furnish all labor tools and equipment, which are necessary to install, complete, and ready for operation, the ductile iron pressure pipe water mains as herein specified and/or as indicated on the contract drawings.

22-4.2 Installation

Installation shall conform to AWWA C 600 and Installation of Ductile Iron Pipe and Fittings in AWWA Manual M41.

22-5 Valve Casing and Lid Installation

When water mains are installed, casings and lids in street areas shall be installed in a lowered position below any sub-grade which may be removed or recompacted.

When sub-grade is compacted and base material installed and completed, casing and lids shall be completed in accordance with Standard Drawing W-7 "Valve Lid & Paving Ring with Galvanized Casing" and W-8 "Installation Procedure for Paving Ring and Lid".

Valves located in the sidewalk shall be marked with a 2" X 4" stake so that casings and lids may be brought to finished grade at the time concrete is poured.

Any excavation necessary for valve casing and lid work shall be thoroughly recompacted to the satisfaction of the Engineer. All casings shall be installed in a vertical position; all valve operating nuts shall be free of any dirt or debris and all valves shall be checked to insure that they are left in a wide open position.

It shall be the responsibility of the Contractor to do this work exactly as specified.

22-6 Earthwork for Ductile Iron and PVC Pipe Installation

22-6.1 Trench Excavation

The trench shall be constructed per City Standard Section 16, City Drawing P-48 and W-29. Unless shown otherwise on the plans a minimum cover of 3.5' is required for mains.

22-6.2 Trench Bottom

The trench bottom should be true and even so that the barrel of the pipe will have soil support for its full length. Earth mounds can be used to support the pipe with the Engineer's approval and under his or her direction. See subsection 21-33 for details.

22-6.3 Bell Holes

Bell holes are required for push-on and mechanical joint pipe. While push-on joints require only a small depression beneath each bell to allow pipe to lay flat on the trench bottom, mechanical joints require additional space for operation of a ratchet wrench. Minor excavations, which are necessary for removing the sling and for assembling the joints, should be made in advance of the laying crew and filled after these operations are completed.

22-6.4 Trench Width

The trench must be wide enough to permit proper installation of the pipe with room for assembling joints and tamping backfill around the pipe. The trench must be at least 12 inches wider than the outside diameter of the pipe to allow for proper placement, tamping, and compaction of the initial backfill. Per the City Standard Specifications, Section 16, the width of the trench at the top of the pipe shall not be greater than 16 inches more than the outside diameter of the barrel of the pipe to be laid therein. These requirements may be modified by the Engineer or as shown on the plans.

22-6.5 Rock or Hard Pan Excavation

In rock or hard pan excavations it is necessary that the rock or hard pan be removed so that it will not be closer than 4 inches to the bottom and sides of the pipe for sizes up to 24 inches in diameter. This same practice shall be followed should the trench excavation pass through piles of abandoned masonry, large pieces of concrete or other debris. The pipe shall not be permitted to rest on masonry walls, piers, foundations or other unyielding, subterranean structures which may be encountered in the excavation.

22-6.6 Barricades and Safety

The Contractor shall follow all the requirements in the City Standard Specifications in Section 7-10.3.

22-6.7 Shoring

In addition to, and consistent with public safety considerations, every precaution for safety must be provided for the workmen at the job site. Shoring must comply with Cal-OSHA Standards.

22-7 Using Earth Mounds

With the Engineer's approval, earth mounds may be used for pipe support if the trench bottom is firm and if firm, mounds can be built that will hold the pipe from settling during assembly and until backfilled. Do not use earth mounds in mucky soil or in wet, mushy trenches. Damp, loamy earth or sand is best.

Locate four equally spaced mounds along each length of pipe. Construct mounds using soil free of rocks, large stones or lumps of clay. The mounds should run completely across the trench - and be at least 6" wide along the length of the pipe. The mound shall be firm and provide a clearance of at least 2" under the coupling.

22-8 Backfilling and Tamping

Backfilling usually follows pipe installation as closely as possible. This protects the pipe from falling materials, eliminates possibility of lifting the pipe due to flooding of open trench, and avoids shifting pipe out of line by cave-ins. The purpose of backfilling is not only to protect the pipe by covering it but to provide firm, continuous support that will prevent the pipe settling or resting on the couplings. The essentials of a first class backfilling job shall be as follows:

Provide continuous bedding or support by carefully consolidating approved material under pipe and couplings and between the run of pipe and the trench walls. Provide a cushion on top by hand - placing approved material to at least 12" over the pipe - the balance can then be backfilled by machine.

The first step in providing firm, continuous support for the pipe-line is to tamp soil solidly under the pipe and couplings. Tamping can be done with tamping bars to consolidate the backfill material. Hand tamping is best accomplished with damp loamy earth or sand.

The initial backfill material used should be slightly damp which will pack more solidly under the pipe. This initial backfill is always placed by hand. It should be shoveled in evenly along both

sides of the pipe, making a layer about 4" thick. Then the tamping bar is used to tamp this soil firmly under the pipe. If more than 4" of soil is shoveled in before tamping, the soil can bridge and fail to go under the pipe. Next, another 4" layer is shoveled in and tamped. This is repeated until the pipe is firmly bedded in compact soil up to the top of the pipe. Two 6 inch lifts are then used to achieve a 12 inch cover over the pipe. This completes what is called the "initial" backfill, the thoroughly tamped soil which provides a continuous supporting bed for the pipeline. Where clay soil or unstable soil is encountered, the pipe should be enveloped in a minimum of four inches of sand - then the backfill completed to at least 12" above the pipe with selected material, then dry sand or other suitable materials should be laid.

The balance of the backfill which is usually placed by machine, need not be as carefully selected as the initial material. If approved by the Engineer, jetting or water tamping will be allowed to achieve the required compaction. Cleanup shall be in accordance with the City's Standards.

22-9 Testing and Sterilization

22-9.1 General

The specifications constituting this section designate the requirements for the procedure, materials, performance, and payment for testing and sterilization of water mains and appurtenances intended for the conveyance of potable water under pressure.

(a) <u>Scope of work.</u> The Contractor shall furnish all labor, material, tools, and equipment, including all chemicals, necessary to perform all operations required to complete the testing and sterilization as herein specified.

22-9.2 Field Testing

- (a) <u>Hydrostatic Pressure test.</u> After the pipe and all appurtenances have been laid and the backfill has been placed and compacted, a hydrostatic pressure test shall be conducted. A hydrostatic test shall be conducted on the entire pipeline for a period of 2 hours at a hydrostatic pressure of 200 psi for Class 200 pipe and 150 psi for Class 150 pipe. In locations where there is a combination of Class 200 and Class 150 pipe, the system testing pressure shall be 150 psi. All valves in the pipeline shall be in the open position during system testing.
- (b) <u>Preparation.</u> The line shall be filled with water at least 24 hours prior to testing. While filling and immediately prior to testing, all air shall be expelled from the pipeline. Where air valves or other suitable outlets are not available for introducing water or releasing air for test purposes, taps and fittings approved by the Engineer shall be installed and later securely plugged.
- (c) <u>Procedure.</u> The procedure shall follow those specified in the AWWA Standard C-600 Sec. 5.2 for ductile iron and C-605 Sec. 7.3 for PVC pipe. The pressure in the pipeline shall be pumped up to the specified test pressure. When the test pressure has been reached, the pumping shall be discontinued until the pressure in the line has dropped 5 psi, at which time the pressure shall again be pumped up to the specified test pressure. This procedure shall be

repeated until the end of the test period. At the end of the test period, the pressure shall be pumped up to the test pressure for the last time. The total quantity of water pumped to maintain pressure shall be measured and compared to the allowable.

(d) <u>Leakage.</u> Shall not exceed the amount calculated, using AWWA Standard C-605 for PVC and C-600 for ductile iron.

22-9.3 Sterilization

Prior to pressure testing and prior to acceptance of work, the entire pipeline including all valves, fitting, hydrants, service laterals, and other accessories shall be sterilized in accordance with AWWA C-601 latest revision. All mains shall be flushed with potable water after completion of construction and prior to disinfection. The Contractor shall provide a sufficient number of suitable outlets at the end(s) of the line(s) being sterilized in addition to those required by the plans, to permit the main to be flushed with water at a velocity of at least 5.5 feet per second over its entire length. The outlets provided shall meet the requirements for fittings as specified for the type main constructed. Temporary blow-offs may be installed during the sterilization and flushing to satisfy these requirements. Drainage facilities shall be constructed such that the water lines cannot be contaminated through the flushing outlet. After flushing, chlorine gas or chlorine compound solution made with liquid chlorine, calcium hypochlorite in solution or sodium hypochlorite solution shall be water mixed and introduced into the mains to form a chlorine concentration of approximately 100 ppm or that which will provide a minimum residual of 50 ppm in all parts of the line after 24 hours have elapsed. During the sterilization process all valves, hydrants and other accessories shall be operated. After chlorination, the water shall be flushed from the line at its extremities until the replacement water tests are equal chemically and bacteriologically to those of the permanent source of supply. The placing of chlorine capsules or tablets in pipe sections during the laying process will be considered as an acceptable method of sterilization. The chlorine water solutions shall be diluted to a chlorine concentration of not more than 100 ppm and not less than 50 ppm measured in the water lines. The Contractor shall keep adequate chlorine residual testing and indicating apparatus available on the site during the entire sterilization period. After final flushing, the flushing fitting shall be plugged with devices intended for this purpose at the pressure class of the pipe. Where water main is coated, plugs and outlets shall be similarly coated. Bacteriologic samples of water for the specified bacteriologic test shall be taken from each end of the sterilized main (located downstream of the point of introduction of chlorine disinfectant and at other locations as determined necessary by the Engineer.) Additional samples shall be taken at intermediate points in such a manner that at least one sample is taken for each 700 feet of main. Bacterial samples will be taken a minimum of 48 hours after the mains have been flushed of all chorine.

The Contractor shall dechlorinate disinfecting water and flushing water if required by the plans or the Engineer.

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